FALL 72
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With cytoplasmic male sterile sunflowers (left), and fertile flowers (right), genuine hybrids are possible. See story page 11.

Avec les fleurs de tournesol à stérilité mâle cytoplasmique (à gauche) et des fleurs fertiles (à droite), on peut obtenir de véritables hybrides. Voir article page 11.

CANADA AGRICULTURE

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La revue trimestrielle *CANADA AGRICULTURE* renseigne les vulgarisateurs et représentants du négoce agricole sur les développements de la recherche et des autres services agricoles du gouvernement fédéral.

Les articles en anglais ou en français doivent être adressés au secrétaire du Comité de rédaction, Division de l'information, ministère de l'Agriculture du Canada, Ottawa.

THE BLIGHT FIGHT

W. C. JAMES, L. C. CALLBECK, W. A. HODGSON and C. S. SHIH

History records the devastation of potato crops by late-blight disease. Caused by the fungus *Phytophthora infestans*, late-blight was responsible for Irelands famine in 1845. Today, more than a century later, this blight is still the most important fungus disease of potatoes throughout the world. Millions of dollars are spent each year in an effort to control it.

Potatoes are grown to some extent in all Canadian provinces, in soil types ranging from the red sandy loams of Prince Edward Island to the dark organic soils of the Red River Valley in Manitoba. Approximately 300,000 acres of potatoes, worth $120 million, are grown annually. One-third of this acreage is grown in the Maritime Provinces, notably in Prince Edward Island and New Brunswick, where the warm and humid climate favors both the production of potatoes and the development of late-blight disease.

Despite many attempts to breed a resistant variety,

The first three authors are plant pathologists with the CDA Research stations at Ottawa, Charlottetown, and Fredericton, respectively. Dr. Shih is a statistician with the CDA Statistical Research Service, Research Branch, Ottawa.

LUTTE CONTRE LE MILDIOU

W. C. JAMES, L. C. CALLBECK, W. A. HODGSON et C. S. SHIH

Les ravages causés par le mildiou aux cultures de pommes de terre sont passés à l'histoire. Provoquée par le champignon *Phytophtora infestans*, la maladie fut responsable de la famine qui sévit en Irlande en 1845. De nos jours, plus d'un siècle plus tard, le mildiou reste la maladie fongique des pommes de terre la plus importante au monde; la lutte pour s'en défendre absorbe tous les ans des millions de dollars.

Toutes les provinces canadiennes cultivent la pomme de terre, dans des types de sol allant des loams sableux rouges de l'Île-du-Prince-Édouard aux sols organiques foncés de la vallée de la Rivière Rouge au Manitoba. Le Canada cultive tous les ans environ 300,000 acres de pommes de terre dont la valeur atteint 120 millions de dollars. Les provinces Maritimes comptent pour un tiers de cette surface, en particulier l'Île-du-Prince-Édouard et le Nouveau-Brunswick, où le climat chaud et humide favorise à la fois la production des pommes de terre et l'évolution du mildiou.

En dépit des nombreuses tentatives de sélection d'une variété résistante, toutes les variétés du commerce sont sensibles à cette maladie, de sorte que les producteurs sont obligés d'avoir recours à des pulvérisations, aériennes ou au sol, couteuses de fongicides On estime que dans les Maritimes les agriculteurs dépensent jusqu'à un million de dollars par an en fongicides, à quoi il faut ajouter les frais de main-d'œuvre, soit une somme du même ordre. En fait, certains dépensent jusqu'à $30 à l'acre pour la lutte contre le mildiou. Des frais de cet ordre peuvent représenter jusqu'à 10% de la valeur commerciale de la récolte.

Les trois premiers auteurs sont des phytopathologistes respectivement attachés aux Stations fédérales de recherches agricoles d'Ottawa, de Charlottetown et de Fredericton. M. Shih est statisticien aux services de recherches statistiques de la Direction de la recherche, à Ottawa.

all the commercial varieties are susceptible, so that potato farmers have to resort to expensive fungicide sprays to control the disease. Aircraft and ground sprayers are used to apply the sprays. It is estimated that in the Maritimes, farmers spend up to $1 million a year on fungicide alone, with additional labor costs amounting to a similar sum. Indeed, some farmers may spend as much as $30 an acre on late-blight control. Such an expenditure could represent 10 percent of the crop's market value.

CONTROL PROFITABLE?

How can we tell whether it is profitable for the farmer to spend $30 an acre on disease control? The vital question can be answered only if we have an estimate of the loss that would have occurred, either: had the crop received fewer sprays and, consequently, suffered more disease damage; or, alternatively, had the crop not been sprayed at all.

In other words, we need a method that allows us to estimate the loss in tuber yield resulting from late-blight epidemics of differing severity, after various spray schedules have been employed. Such a method should be able, at the end of a season, to demonstrate to the farmer the economic gains or losses accruing from different spray schedules. The estimation procedure should be capable of indicating the need for a more intensive spray schedule or, alternatively,

LA LUTTE EST-ELLE RENTABLE?

Vaut-il la peine pour un producteur de dépenser $30 à l'acre pour lutter contre le mildiou? On ne peut répondre à cette question essentielle que si l'on dispose d'une estimation des pertes susceptibles de se produire dans le cas où 1) la culture recevrait moins de pulvérisations, et par conséquent souffrirait de dégâts plus graves; ou, 2) si la culture ne recevait aucun traitement.

En d'autres mots, il est nécessaire de disposer d'une méthode qui permette d'estimer les pertes en tubercules venant de manifestations de mildiou d'intensité différente, et cela après avoir employé différents programmes de pulvérisation. Grâce à une méthode de ce genre, à la fin de la campagne, il serait possible de faire connaître à l'agriculteur les bénéfices financiers ou les pertes provenant des différents programmes de traitement. La méthode devrait indiquer le besoin d'un programme plus intensif ou, au contraire, les inconvénients financiers de pulvérisations trop nombreuses.

Des études récentes aux stations fédérales de recherches agricoles de Charlottetown (Île-du-Prince-Édouard), Fredericton (Nouveau-Brunswick), et Ottawa, ont précisément conduit à la mise au point d'une méthode d'estimation des pertes en tubercules, en fonction de l'importance de la maladie à différen-

A potato leaf infected with late blight.
Feuille de pomme de terre infectée par le mildiou.

Aerial spraying protects potato crops from late-blight disease.
Les pulvérisations aériennes protègent les pommes de terre contre le mildiou.

KEY FOR THE ASSESSMENT OF POTATO LATE-BLIGHT ON FOLIAGE		CLÉ D'ÉVALUATION DES ATTAQUES DE MILDIOU SUR LE FEUILLAGE
Nature of infection	Blight Mildiou (%)	Nature de l'infection
No disease observed.	0.0	Nulle.
A few scattered plants blighted; no more than 1 or 2 spots in 12-yard radius.	0.1	Quelques plants isolés atteints; pas plus de 1 ou 2 taches dans un rayon de 12 verges.
Up to 10 spots per plant; or general light infection.	1	Jusqu'à 10 taches par plant, ou infection légère généralisée.
About 50 spots per plant; up to 1 in 10 leaflets infected.	5	50 taches environ par plant; de 1 à 10 folioles atteintes.
Nearly every leaflet infected, but plants retaining normal form; plants may smell of blight; field looks green although every plant is affected.	25	Presque toutes les folioles sont infectées, mais les plants conservent une forme normale; les plants peuvent commencer à sentir le mildiou; le champ paraît vert, bien que tous les plants soient touchés.
Every plant affected and about 50 percent of the leaf area is destroyed; field appears green, flecked with brown.	50	Tous les plants sont touchés, et environ 50% de la surface foliaire est détruite; le champ paraît vert avec des taches brunes.
About 75 percent of leaf area destroyed; field appears neither predominantly brown nor green.	75	Environ 75% de la surface foliaire est détruite; la couleur dominante du champ n'est ni brune ni verte.
Only a few green leaves on plants, but stems are green.	95	Quelques feuilles vertes seulement restent sur les plants, mais les tiges sont vertes.
All leaves dead, stems dead or dying.	100	Toutes les feuilles sont mortes, les tiges sont mortes ou mourantes.

(After BMS 1947)
(D'après la "British Mycological Society", 1947)

the economic disadvantages of too many spray applications.

Recent studies at the Canada Department of Agriculture's Research Stations in Charlottetown, P.E.I., Fredericton, N.B. and in Ottawa, have led to the development of just such a method for estimating the loss in tuber yield, given the amount of disease at various times during the course of the season. In our studies, the difference between estimated and actual loss was less than five percent in nine cases out of 10.

DESTROYS LEAF

Late-blight decreases tuber yield in potato plants, by reducing the green leaf area available for photosynthesis. The disease develops as dark green or brownish-black blotches on leaves and stems and may spread rapidly until all the foliage is blackened. If the crop is badly managed, and if recommended topkilling sprays are not used to kill infected plant material prior to harvest, additional losses may be incurred through tuber rot caused by the same fungus. However, it is not feasible to estimate losses resulting from blighted tubers because the amount of loss is affected by factors that vary from site to site. Such factors include: tuber susceptibility of the particular variety; type of soil; depth of earth cover; rainfall.

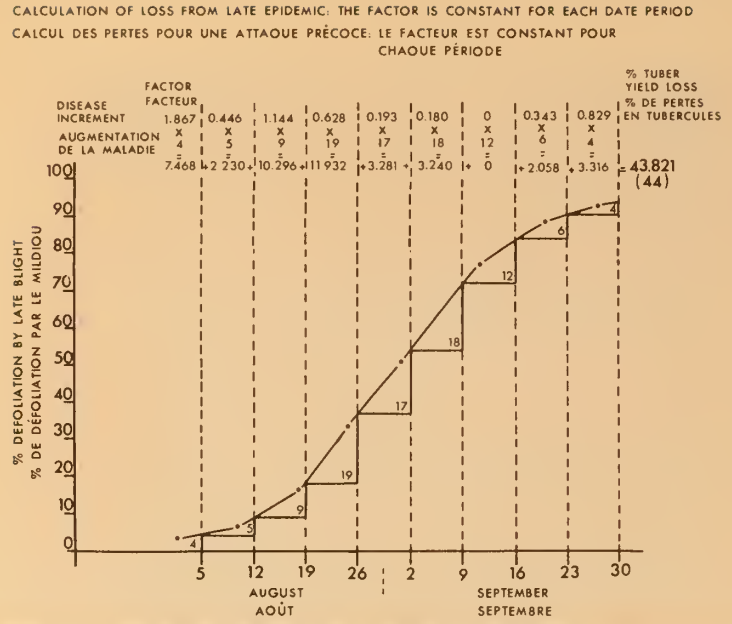
The disease assessment key given with this article

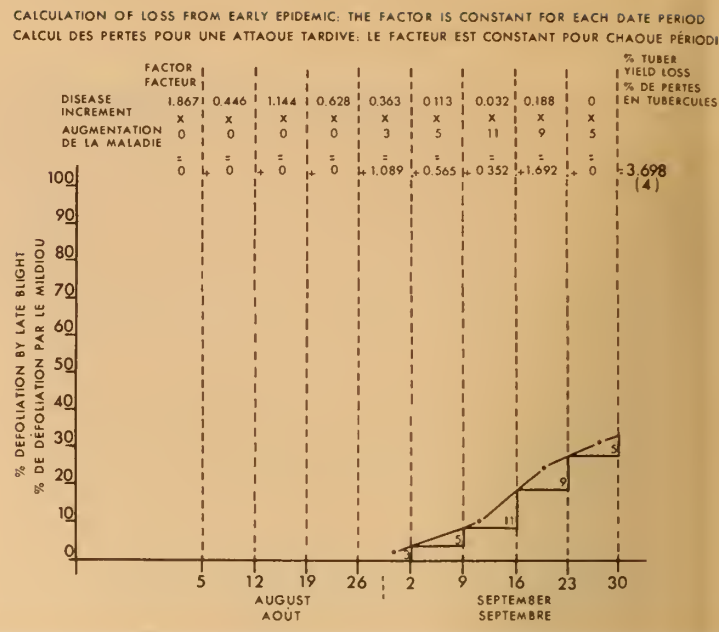
tes époques de la campagne. Dans ces études, la différence entre les pertes prévues et les pertes réelles a été inférieure à 5% dans neuf cas sur dix.

PERTE DU FEUILLAGE

Le mildiou diminue le rendement en tubercules des pommes de terre, en réduisant la surface foliaire disponible pour la photosynthèse. Il provoque des taches vert sombre ou brunâtres sur les feuilles et les tiges et peut se répandre rapidement à la totalité du feuillage. Si la culture est gravement attaquée, et si l'on n'effectue pas les pulvérisations de défanage recommandées afin de détruire le matériel végétal infecté avant la récolte, des pertes supplémentaires peuvent se produire, ce même champignon provoquant alors une pourriture des tubercules. Il est cependant malaisé d'estimer les pertes provenant des tubercules attaqués, étant donné que leur importance varie selon des facteurs qui ne sont pas partout les mêmes. Ces facteurs comprennent: la sensibilité des tubercules d'une variété particulière; le type de sol; la profondeur d'enfouissement des tubercules; la pluviométrie.

La clé d'évaluation de la maladie, exposée ci-après, a été mise au point par la "British Mycological Society" en 1947. Dans nos travaux, nous nous en sommes servis comme d'un guide pour mesurer le





Two graphs show the predictable percentage difference in tuber loss resulting from potato late-blight infection starting in early August or early September. In each case, the given factors are keyed to the date, and are constant for early or late epidemics respectively. To determine the extent (percentage) of blight infection at specific times during the growing season, use the assessment key. At weekly intervals multiply the percentage of infection by the given relevant factor for early or late epidemic to give the percentage loss in tuber yield.

Grâce à la clé d'évaluation, on peut déterminer, en pourcentage, l'étendue d'une infection de mildiou à des moments précis au cours de la campagne. En multipliant ce pourcentage par un facteur correspondant, à des intervalles hebdomadaires, il est possible de prévoir l'effet de la maladie sur le pourcentage de pertes en tubercules à la fin de la campagne ainsi que les effets des mesures de lutte. Deux schémas montrent la différence en pourcentage des pertes en tubercules auxquelles on peut s'attendre, pour une infection tardive commençant au début de septembre, et pour une infection précoce commençant au début d'août.

was developed by The British Mycological Society in 1947. In our studies, we used it as a guide to measure the percentage of disease damage evident at various points during the season. Two graphs are given as examples to show how loss in total potato tuber yield can be calculated, using the following four steps:

1. With the assessment key as a guide, record disease progress on a scale as shown in the two example graphs.
2. Construct a straight-line graph of disease progress, by joining consecutive assessments as recorded with aid of the key.
3. Classification: If the disease progress-chart indicates more than 10 percent on Sept. 2, classify infection as early; if the chart indicates 10 percent or less, on Sept. 2, classify infection as late.
4. Calculate the weekly increments of disease; multiply the result by the relevant factor[1] as shown in the examples. Take the sum of the weekly product as an indication of percentage loss in total tuber yield.

At present, the method can be used only at the end of a season, to demonstrate the inadequacy of a spray schedule. The aim, however, is to persuade farmers to seek advice from extension officers, regarding spray recommendations. The farmer could then operate a more efficient spray-schedule the following season. ■

[1]The relevant factors shown in the sample graphs are constants based on statistical analysis of experimental data, and are keyed to date periods that relate to early or late epidemics, respectively.

pourcentage de dégâts à différents moments de la campagne. Les figures permettent de voir comment calculer les pertes totales en tubercules, en utilisant la démarche exposée ci-après:

1. A l'aide de la clé, enregistrer l'avance de la maladie sur une échelle comme on peut le voir dans les exemples.
2. Construire une courbe des progrès de la maladie en joignant les évaluations successives telles qu'elles ont été déterminées à l'aide de la clé.
3. Classement: si la courbe de progrès de la maladie est supérieure à 10%, au 2 septembre, classer l'infection comme précoce; si la courbe ne dépasse pas 2%, au 2 septembre, classer l'infection comme tardive.
4. Calculer l'augmentation hebdomadaire de la maladie; multiplier le résultat par le facteur correspondant[1], comme dans les exemples. La somme du produit hebdomadaire est une indication du pourcentage de pertes totales en tubercules.

A l'heure actuelle, on ne peut utiliser cette méthode qu'à la fin d'une campagne, pour établir l'insuffisance d'un programme de pulvérisations. L'objectif poursuivi est d'inciter les producteurs à demander l'avis des agents de vulgarisation en ce qui concerne les recommandations de pulvérisations. Chaque producteur pourrait alors, au cours de la campagne suivante, effectuer ses traitements suivant un programme plus efficace. ■

[1]Les facteurs correspondants, figurant aux tableaux sont des constantes basées sur une analyse statistique de données expérimentales.

FORAGE SEED SPECIALISTS VIEW TRADE EXPANSION

Hills of central Hokkaido, cleared for forage and forestry production, had snow cover in mid-April 1972, at time of Canadian visit.

D. W. MacDONALD

Le Japon s'oriente vers la production de fourrages, étant donné la demande accrue de bœuf et de produits laitiers. L'Association canadienne des producteurs de semences, avec l'aide technique des spécialistes gouvernementaux, a récemment organisé un voyage d'étude au Japon afin de mettre au point un plan d'action concerté permettant de satisfaire aux besoins de ce marché.

Japan is getting into forage production in support of a growing demand for beef and dairy products. There's a market for forage seed and the Japanese government is anxious to diversify its seed sources to ensure the best quality at competitive prices. At present, the United States is the main supplier of forage seed but it is believed that some of this may have been grown in Canada.

This was the situation observed by a Canadian forage seed mission to Japan last spring, organized by the Canadian Seed Growers Association. The mission, including specialists in all phases of forage production, from all parts of the country, studied Japanese conditions with a vew to planning a concentrated effort to meet their market requirements. Because grasslands are limited in Japan, H. Masuda, Director General, Japanese Livestock Industry Bureau, stressed that they had to get the highest yielding forages possible.

CSGA general manager, E. T. McLaughlin, headed the mission, arranged largely by federal Industry, Trade and Commerce representative, William K. Robertson. Dr. W. R. Childers, plant breeder and Dr. W. P. Campbell, Plant Protection Division, Canada Agriculture, Ottawa, advised on technical matters related to expansion of forage seed trade with Japan.

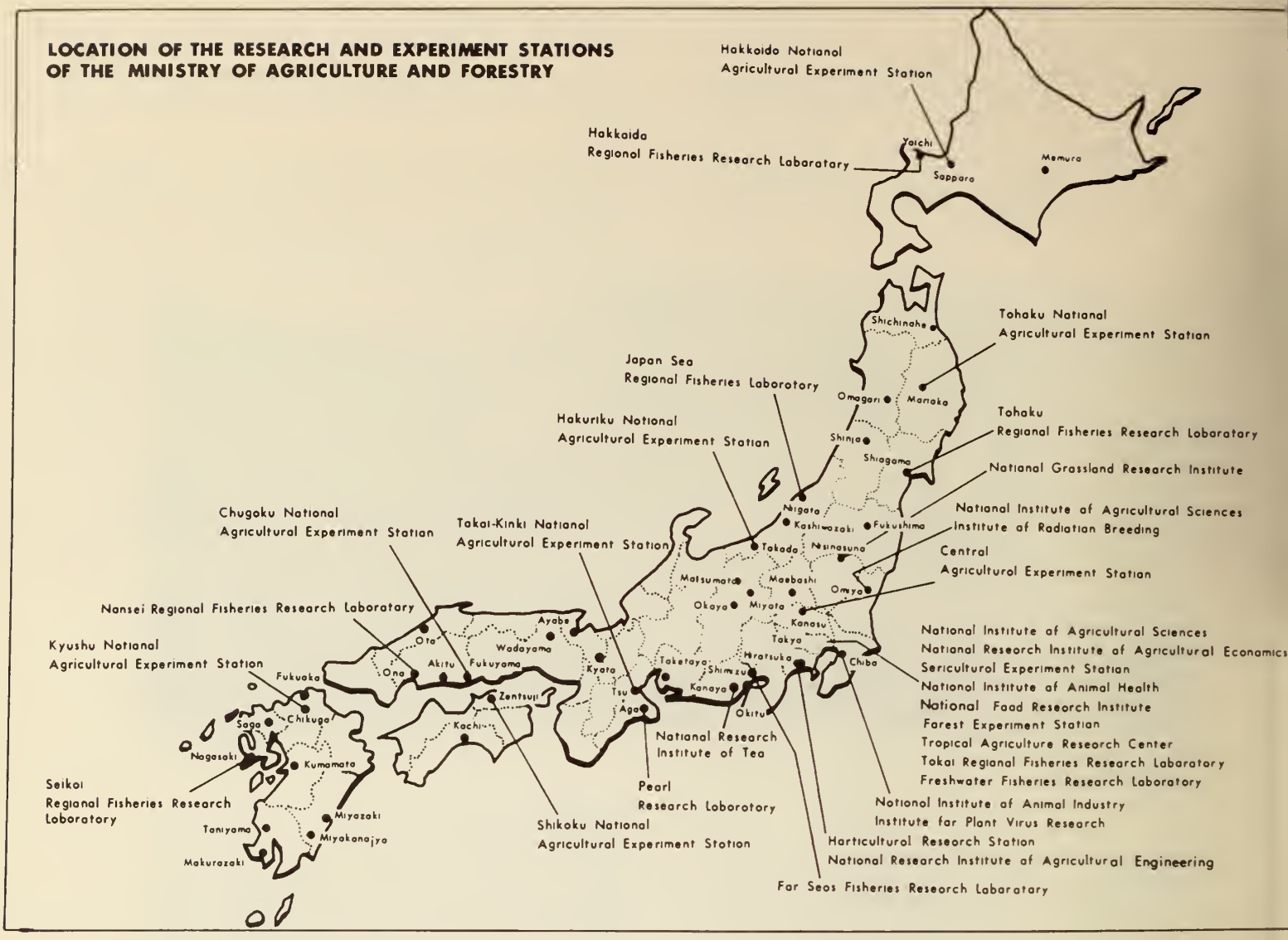
The mission found Japanese research and knowledge of plant breeding to be first rate, and their facilities and organization excellent. However, the history of grassland research goes back only twenty years. It is centered at the National Grassland Research Institute Nishi Nasuno (Nasu), but prefectural areas have stations where grassland work is being carried out. New forage varieties, bred for Japanese conditions, will no doubt be forthcoming as a result of the new emphasis on forage research and breeding.

UNFAVORABLE CLIMATE

But the Japanese climate is not suitable for forage seed production, nor do they have the land available for such enterprise. Only three per cent of the total seed used in Japan is of domestic production. Of the seed used, 10 per cent is bred in Japan and contracted for increase in other countries.

Canada has the climate and our seed-producing areas are ideally suited to take advantage of this situation, Dr. Childers observed.

Mr. MacDonald is Head, Periodicals Services Unit, Information Division.



Japanese seed companies buy on the world market. One company imports Climax timothy, meadow fescue, alsike and altaswede red clover from Canada. Timothy, orchardgrass and meadow fescue are in most demand. Lawn grass seed is increasing in importance, including Kentucky bluegrass and red fescue. Japanese dealers are interested in red top for erosion control in waste places, and pubescent wheat in northern areas.

There's a demand for cold resistant white clover, according to Dr. Childers, but the Japanese are worried about the possible introduction of virus diseases. They are very conscious of the danger of introducing new fungi, nematodes, bacteria or virus into new forage areas.

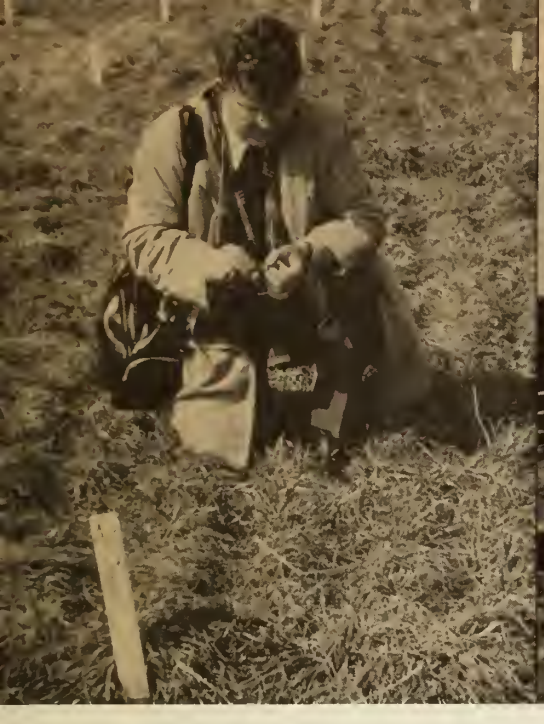
The Japanese have experienced poor germination with some imported orchardgrass. The Canadians believed this could have been low-priced seed because it was old and carried no germination guarantee. Pedigree seed of Canadian named varieties on the other hand would guarantee the standard of purity and germination.

The Canadian Seed Growers Association has 7,000 member growers, producing over 106,000 acres of pedigree forage seed. Along with the CDA Plant Products Division, the Association maintains the standard for genetic purity, and quality of Canadian pedigree seed. The Canadian Certified seed system also allows for foundation seed of foreign varieties to be increased in this country for return to the country of origin.

It was learned that in Hokkaido, legislation is being planned to require that only Certified seed be used in better farming programs. The prefecture is also trying to interest the federal government in making use of Certified seed a national policy. At present, Japanese farmers are advised to use Certified seed to qualify for subsidies based on production.

Japan has a total of six million hectares of arable land. One half of the area is in rice production. Only since 1950 has there been much activity in forage crops because of increased demand for beef and dairy products by a population enjoying a higher standard of living. The land available for forage is mainly mountain areas which are being cleared and put to grass.

The Tohoku National Agricultural Experiment



Station at Marioka is situated in the northern third of Honshu Island, the main food source area of Japan. The main crop is rice but the move is to a large livestock industry. Land is being cleared for forage, and mountains leveled for grazing. At present, 120,000 acres are available for livestock production.

The northerly Island of Hokkaido represents 20 per cent of the land area of Japan. Rice has been the number one crop in the southern lowlands. Production is limited in the eastern and northern parts because of cold weather and it is this area that is marked for increased forage production.

Dr. H. Oohara, president of Obihiro Livestock University told the mission he would like to see three million acres of grass seeded on Hokkaido. They plan to establish and renovate 30,000 hectares a year, requiring 900 tons of seed.

FOUR YEAR ROTATIONS

Grass stands last about four years on Hokkaido, Dr. Childers observed. Some of them yield 60 tons of green weight per hectare under optimum conditions. Rotations are followed to control disease and insects. Corn, beans and vegetables are grown in some areas, but only timothy does well in the northern regions. The aim is good management so that grasses will stay longer before reseeding is required.

In high country grassland areas, rice farmers are being trained to manage dairy and beef farming operations.

The soil is largely volcanic ash with poor internal drainage. This causes problms in grass production. Summers are cool and winter temperatures go below –20 to –30 degrees C. In the highland area, the length of day is longer which helps growth.

The Japanese place great emphasis on disease resistance—perhaps too much. Dr. Childers attributed

(Left) Dr. Childers examines some of his Champ timothy that overwintered in test plots at Kitami Research Station, Hokkaido.

(Above) Silos rise only 18 to 22 feet on Japanese farmsteads, and are often loaded and unloaded by hand.

(Below) Ladino clover plots are weeded by hand in the shadow of Mount Iwate at the Tohoku National Agricultural Experiment Station, Marioka, Japan.

Members of Canadian Forage Seed Mission to Japan were, left to right: Standing, J. C. Brown, Rapeseed Association of Canada; O. G. Bratvold, Alberta Department of Agriculture; E. T. McLaughlin, CSGA, Ottawa; G. H. Beatty, CSGA president, Watrous, Sask.; Dr. W. R. Childers, CDA Research Branch, Ottawa. Seated, Dr. W. P. Campbell, CDA Plant Protection Division, Ottawa; E. Umemoto, Canadian Embassy, Tokyo; W. K. Robertson, Industry, Trade and Commerce Department, Ottawa; Kneeling, W. H. Shanks, Wheatley, Ont.; K. C. Long, Cardston, Alta.

this interest, especially on non-economic diseases, to the enthusiasm of the micologists, plant pathologists and their limited association with grass breeders who have observed the effects of diseases on grasses over a long period.

PLANT PROTECTION

Ergot is the main concern. However, Dr. Campbell noted that species of ergot in Canada are similar to those occurring in Japan, and there is no real danger of introducing new species. Normally, grasses are harvested in the green stage, therefore cannot cause damage to cattle in this condition. Strict regulations cause 95 per cent of seed samples to be rejected for ergot, which unfortunately adds to the cost of seed to the importer.

Dr. Childers believes that greater emphasis could be placed on screening for disease resistance in Canada. Some of this work is already being done with Heterosporium phlei on timothy at Saskatoon. Large nuseries are being planted at Ottawa for further screening for rust and other diseases. Perhaps some of the emphasis on disease loss by our plant pathologists could be switched toward inheritance of disease resistance and selection for improved resistant strains.

As a result of this mission, Canadian forage varieties will receive more extensive testing in Japan. Fifty pound lots of Canadian Certified forage varieties have been sent to Sapporo for use in testing and grazing trials. Plans are going ahead to supply mixtures and management data that may be adaptable to the new grassland areas of northern Hokkaido. Forage researchers in Canada should take a look at the legume seed potential of the Creston, B.C., area, Dr. Childers believes; also the native timothy stands in the foothills of Alberta and B.C. He recommends further study of tetraploid production of clovers and grasses in Canada for possible application to the Japanese market.

Some corn hybrids have been sent to Obihiro. It's possible that our earliest hybrids, either of the grain or silage types, will be adaptable to the Hokkaido area and open the door to increased trade in seed production.

But it's a specialized, competitive market and Canadian seed growers will need all the technical expertise and support of all segments of the seed business to meet the supply standards set by the Japanese.

We have to show the Japanese that we can supply the quality of seed required as well as the mixtures best adapted to their conditions, Dr. Childers concludes. ■

NEW ADVANCES IN HYBRID SUNFLOWERS

HENRY ENNS

Grâce à la stérilité mâle cytoplasmique, on peut aujourd'hui créer de véritables hybrides du tournesol.

The discovery and isolation of cytoplasmically controlled male sterile sunflower strains by Dr. Patrice LeClerq in 1967 was a very important step in the search for hybrid vigor in sunflowers. The male sterility resulted from a cross made at Clermont-Ferrand, France, between Helianthus annuus and H. petiolaris. Progeny of these crosses produced no viable pollen, due to the nature of the cell sap, and therefore could not be self pollinated. Any seed set was the result of a cross, and therefore was a genuine hybrid. This opened the door for 100 percent hybrid varieties in sunflowers.

Previously, so-called hybrid sunflower varieties were only partly hybrid, because a proportion of selfed seed was mixed in with seed resulting from cross pollination.

While cytoplasmic male sterility allowed for production of genuine hybrids, there was no way of using this commercially because the following generation is again sterile. To use this system, lines containing pollen fertility restorers were necessary.

In 1969, the plant breeders at Agriculture Canada's Research Station, Morden, Man., secured seed of the male sterile lines to look for restorers. Using them as female parents, the male sterile lines were crossed with wild sunflowers (mostly H. annuus) and other varieties in the Morden collection. The Morden collection was largely built over the years by Dr. E. D. Putt, Station Director, in his search for disease resistant material.

Dr. Enns is the sunflower breeder at CDA Research Station, Morden, Man.

In any case, many fully fertile plants were found in the progeny. The search for restorer genes looks promising indeed. It was concluded that one could find fertility restoration in most good sized populations of wild sunflowers. Another plant breeder in the U.S.A. found a restorer in an inbred line which can be used as it is.

The two restorers worked on most at Morden appear to be single dominant genes conferring complete pollen fertility on the progeny of their crosses. They have been checked in the greenhouse, growth cabinet and in the field. The genes, after being transferred through several generations, have proved reliable, and the cytoplasmic sterility is behaving equally well under different conditions.

It is believed the system will work. By backcrossing, the restorer genes can be introduced fairly quickly into the parents of prospective hybrids. Genuine hybrids, with 100 percent crossed seed should be feasible. Yield increases of 25 percent or more are predicted for genuine hybrids.

At Morden, we are producing seed for 27 hybrids using the cytoplasmic restorer system. Fourteen hybrid sunflower combinations were tested in the United States in 1972. At least one hybrid will be grown commercially on a small scale in the United States next year. If one of these combinations proves to do well in Canada, then hybrid sunflower seed could be available in a few years.

Valley, the latest partial hybrid released from Morden, had a female parent that was partially sterile. In small crossing blocks, this female parent produced a comparatively high percentage of hybrid seed. In a 1½ acre crossing block in 1967, the amount of crossing was about 80%. The amount of hybrids in the seed in 1968, '69 and 1970, was estimated at 43, 48 and 59 percent respectively. This is not good enough today. With cytoplasmic male sterility, and restorer genes, the CDA plant breeder at Morden is now aiming for 100 per cent hybrid sunflowers. ■

DOUBLEZ VOS RENDEMENTS AVEC LA LUZERNE

JEAN GENEST

Research at CDA Research Station, Lennoxville, Que., indicates that dry matter in forage production could be doubled by using alfalfa. Tests reveal that alfalfa grows well in Quebec, on properly drained soil in which the pH reaction is adequate.

La productivité de la luzerne, plus élevée que celle des autres plantes fourragères, et sa haute qualité, en font une culture avantageuse sous nos conditions surtout si on la compare à la fléole des prés (ou mil) qui constitue la principale culture à foin.

D'après les recherches faites à la Station de recherches de Lennoxville son utilisation devrait permettre de doubler les rendements en matière sèche tout en augmentant de 7 à 8% la valeur protéique par rapport à la fléole. Même si certains disent que la luzerne n'est pas très bien adaptée à notre climat, elle est cultivée aussi bien dans les régions désertiques qu'au cercle arctique.

DRAINAGE

L'acidité du sol et le mauvais drainage ont retardé l'introduction de la luzerne dans les régions de l'est mais ces deux facteurs peuvent se corriger. Ces conditions satisfaites, que le sol soit graveleux ou d'argile très lourde, la luzerne pousse bien.

Le développement radiculaire de la luzerne s'effectue en profondeur contrairement aux graminées qui développent leurs racines surtout en surface. Par conséquent, la nappe phréatique doit être maintenue constamment à 3 pieds de profondeur. S'il y a variation, la partie profonde des racines risque d'être endommagée par asphyxie. Le drainage souterrain diminue également les risques de déchaussement. Le drainage superficiel importe surtout pour éviter la formation de glace de surface au printemps. Cependant, la luzerne peut supporter au printemps des inondations de quelques jours sans dommages appréciables.

M. Genest est spécialiste en botanique et en culture fourragère à la station de recherche d'Agriculture Canada à Lennoxville, Qué.

Il est facile de s'assurer que le drainage souterrain est suffisant en perçant des trous à la tarière. Le niveau d'eau, 24 heures après ne devrait pas venir à moins de trois pieds de la surface du sol.

ACIDITÉ (pH)

La réaction du sol doit être maintenue entre 6.5 et 7 pH. Sinon, les chances de succès sont très incertaines. En effet les rhizobiums, qui permettent la fixation de l'azote chez les légumineuses, ne subsistent pas dans les sols acides. Si nécessaire, il faut étendre de la chaux de préférence l'année précédant le semis ou tout au moins trois à quatre semaines avant le semis.

Comme les rhizobiums ne subsistent pas en milieu acide et qu'une modification du pH du sol n'en crée pas, il faut inoculer la semence de luzerne avec un inoculant approprié. On utilise pour ce faire un produit commercial composé de bactéries fixatrices d'azote et de tourbe finement moulue. Le mélange est vendu en quantités suffisantes pour traiter 50 livres de semences environ.

Une inoculation efficace s'obtient en saupoudrant de l'inoculum sur la semence préalablement mouillée. Pour mouiller un boisseau de semence il faut 1½ chopine d'une solution composée de 2 cuillérées à table de sirop de maïs dans une pinte d'eau chaude. Bien remuer la semence de façon que chaque graine porte un peu d'inoculum. Mettre ensuite à sécher à l'ombre en retournant fréquemment. Le soleil détruit les bactéries de l'inoculum.

ENGRAIS

Il va sans dire que la fertilisation d'une luzernière se fait après une analyse du sol. Pourtant il faut mentionner que le phosphore est l'élément déterminant au moment du semis tandis que le potassium maintient la production les années suivantes.

Comme exemple, disons que 400 livres à l'acre de 5-20-10 conviendraient la première année et que 400

Parcelles de luzerne illustrant la nécessité d'un pH adéquat et d'une bonne fumure potassique.

livres à l'acre de 0-15-30 conviendraient aux années suivantes pour un sol de fertilité moyenne.

La luzerne est très exigeante en bore et nos sols en sont pauvres. Lors de l'analyse du sol il est bon de demander l'analyse en bore des échantillons.

MAUVAISES HERBES

Il est dans la tradition québécoise de semer les herbages en compagnie de plantes-abri pour réprimer les mauvaises herbes. Mais elles aussi consomment de l'énergie comme les mauvaises herbes. Les herbicides modernes effectueront ce travail plus efficacement. La plante-abri conserve sa valeur cependant pour prévenir l'érosion du sol.

L'Eptam 7.2, au taux de 3 chopines contre les annuelles et 4½ à 6½ chopines contre le souchet, détruit les mauvaises herbes lors du semis. Ce travail s'effectue après une bonne préparation du sol en faisant pénétrer l'herbicide 4 à 5 pouces dans le sol à l'aide d'une herse derrière le pulvérisateur. Disquer dans l'autre sens dès que le premier demi pouce de sol est sec. Si la moutarde et le chou gras résistent à ce traitement, une application de 50 onces à l'acre de 2,4D-B 64, lorsque la luzerne possède 2 à 4 feuilles trifoliées, devrait en venir à bout.

DENSITÉ DU SEMIS

Bien que certains recommandent des doses supérieures à 10 ou 12 livres à l'acre, ceci à notre avis constitue un maximum. En effet, un bon peuplement signifie 10 à 12 plants par pied carré, l'année du semis et 5 à 7 les années suivantes. Un semis de 10 livres à l'acre contient assez de graines pour établir plus de 50 plants par pied carré. La profondeur idéale de semis est d'environ ½ pouce, juste assez pour recouvrir la semence lorsque le sol est humide et assez profond lorsque le sol est très sec. Le maximum se situe à un pouce pour les sols lourds et 1½ pouce pour les sols légers.

Champ de parcelles de luzerne. Ces parcelles sont établies en vue de déterminer la meilleure façon de régir la luzerne sous les conditions des Cantons de l'Est.

Habituellement, les semis s'effectuent tôt au printemps lorsque nous utilisons une plante-abri mais peuvent être effectués jusqu'à la mi-juin.

Les variétés recommandées dans le Québec sont Alfa, Glacier, Saranac, Vernal, Iroquois et Warrior. Les trois premières sont hâtives et leur végétation commence tôt au printemps tandis que les autres, normalement plus résistantes, sont tardives.

LA RÉCOLTE

Le temps et la fréquence des coupes sont très importants puisqu'ils conditionnent la productivité, la durée du semis et la résistance au froid et à la sécheresse.

Le stade idéal, compte tenu de la productivité, de la qualité et de la persistance, se situe au début de la période de floraison. Il faut observer le repos automnal de la luzerne pour que celle-ci emmagasine le plus de réserves possibles dans ses racines. Pour cette raison elle ne devrait pas être fauchée de la dernière semaine d'août à la mi-octobre. Ce stade de réserves maximum est atteint à la pleine floraison.

La luzerne peut être pâturée bien que ce ne soit pas une plante à pâturage. Toutefois, elle ne devrait pas être pâturée en temps humide puisque cela peut endommager les couronnes et réduire le peuplement, de même elle ne devrait pas être pâturée à moins de 3 pouces du sol.

VALEUR NUTRITIVE

Le stade de maturité à la récolte, le séchage et le mode de conservation influencent grandement la valeur nutritive.

Comme les feuilles forment 50% de la matière sèche et contiennent 75% de la protéine de la plante, toutes les manipulations devront éviter les pertes de feuilles. C'est le secret d'un bon fourrage.

Il faut donc râteler avant que le fourrage ne soit trop sec. Ne pas oublier non plus que la valeur nutritive diminue avec la maturité. L'ensilage de luzerne, bien que plus difficile que l'ensilage de maïs, permet une meilleure conservation de la matière sèche et de la protéine puisque 31% de la protéine sont perdus par la fenaison, tandis que 15% seulement sont perdus par ensilage.

Faucher la luzerne pour l'ensilage, comme le foin, au début de la floraison. Un fanage de quelques heures diminuera l'humidité de 65 à 70%. Les conditions de fermentation devront être idéales, c'est-à-dire l'air sera exclu le plus possible, la coupe sera fine (⅜ de pouce) et le silo étanche, faute de quoi on emploiera une pellicule de polyéthylène.

La luzerne ne contient que 4.3% d'hydrate de carbone par rapport au maïs qui en contient 20.3%. Voilà pourquoi elle est plus difficile à ensiler. La fermentation est moins rapide et le degré d'acidité requis prend plus de temps. Pour pallier cette difficulté on peut ajouter 100 à 200 livres de grain par tonne d'ensilage. Le grain n'est pas perdu puisque les animaux le mangent en même temps que l'ensilage. ■

PROJECT 75

Members of Canada Agriculture's task force for Project '75 include, from left: Dr. R. K. Downey, Grant Devine, Dr. A. E. Hannah, Dr. D. P. Heaney, Dr. A. S. Johnson and R. E. Wight. A. A. Beaulieu, who does not appear in the group, was appointed to the task force in July.

Le Projet 75 est un essai, orienté vers le marché, de mise au point des priorités et des objectifs nationaux, en ce qui concerne les circuits alimentaires. Un circuit alimentaire comprend l'ensemble des activités agissant l'une sur l'autre et constituant la production, la préparation, la commercialisation et la consommation des denrées alimentaires canadiennes, du producteur au consommateur. Grâce au Projet 75, les coordonnateurs ont le ferme espoir de mettre en place un mécanisme favorisant les communications entre les différents éléments des circuits alimentaires, où tous les intéressés travailleront ensemble vers un objectif commun et une planification fructueuse permettant de satisfaire à la demande du marché.

JANET LONG

'All with a stake—participate.' That's the basic philosophy and principle for success behind Agriculture Canada's new Project '75.

Only with voluntary cooperation and enthusiastic participation from all groups involved in the food system—from producer to consumer—can the Project's overall aim of promoting communication between these components be achieved, says Dr. A. E. Hannah, project leader.

Project '75 is a test for a market-oriented approach in the development of national objectives and priorities for the food system.

A "food system" is defined as all the interacting activities which together constitute the production, preparation, marketing and consumption of food and its by-products from the producer to the consumer. Factors that influence the food system include legislation, quality control, research and development, information flow, use of resources, department extension work, knowledge of the market, and problems of production.

THREE COMMODITIES

As an endeavor which the department may develop into a full food system program, Project '75 at present involves only three food commodities: beef, oilseeds and high energy grains.

These items were chosen because of their importance in the market, their interaction with one another, and because they are growth commodities. As

Janet Long is on the staff of the Information Division, Canada Department of Agriculture, Ottawa.

an initial step towards a fuller program, the Project must begin by continually developing opportunities for a growing commodity system, says Dr. Hannah.

The three commodities cover the whole range of market possibilities. Beef is directed at a domestic market, with international overtones; oilseeds, including rapeseed, sunflower seed, and soybean, are primarily for export, with some domestic potential; while high energy feed grains such as barley, corn, oats and wheat, supply both domestic and export markets and have an impact on the beef industry. Grain is in competition with oilseed for land and transportation-handling facilities in Canada.

An outline of achievement for the Project has been drawn up for three years—until 1975—the Project's namesake.

TASK FORCE

To date, seven of Agriculture Canada's agricultural and research officers have been appointed as a Task Force to lay the groundwork for the Project, which was announced September, 1971: Dr. Hannah, Planning and Coordination, Research Branch; D. G. Devine, Marketing Specialist, Production and Marketing Branch; Dr. R. K. Downey, Research Scientist (Plant), Saskatoon; Dr. D. P. Heaney, Research Scientist (Animal), Ottawa; Dr. A. S. Johnson, Coordinator, Research Branch; R. E. Wight, Plant Products Division, Production and Marketing Branch; and A. A. Beaulieu, Former Research Director St. Jean, Qué.

A senior coordinator for each commodity system involved in the Project will be appointed as well as a general Project leader with a support staff. Progress reports will be given each year beginning May 1973, and budgets will be drawn up accordingly.

Commodity coordinators hope to build up a mechanism that promotes intensive communication between components of the system leading toward common goals and mutual success. Once a blue print for an organization through which components can consult is established, other commodity systems and their national objectives can be developed within a similar framework.

COMMENTS STUDIED

At this stage in the Project, coordinators are studying comments received from spring meetings held in each province, and attended by provincial and federal government representatives along with members of some component groups.

During the meetings, group members were asked the questions Project '75 coordinators hope to answer in order to set up a workable organization for consultation:

How can better inter-component communications be developed? How can such communication be maintained while coordinators are trying to formulate national priorities and objectives for commodity systems? With "trade offs" necessary and agreement not possible for all areas, how can frank, unpolarized, continuous discussion on a technical level go on between governments and other system components outside government control? What mechanism can be used for continuous reshaping of national priorities? How can coordinators promote increasing awareness among the groups of the reasons for necessary compromises that must be made in formulating objectives, and of the inter-relation between commodity systems?

From comments received, coordinators hope to present an outline of a consultation mechanism to the groups for approval.

But this doesn't mean that contact has been made with everybody, says Dr. Hannah. Coordinators will continue to work with existing organizations or with individual "experts" in each of the commodity systems, in order to develop national commodity goals and the programs needed to implement them.

NATIONAL OBJECTIVES:

For agribusiness, national objectives could help provide direction for business decisions, and allow them to develop their own objectives within the national framework.

For the government, the objectives could be a basis for planning projects and commitment of funds, personnel and facilities.

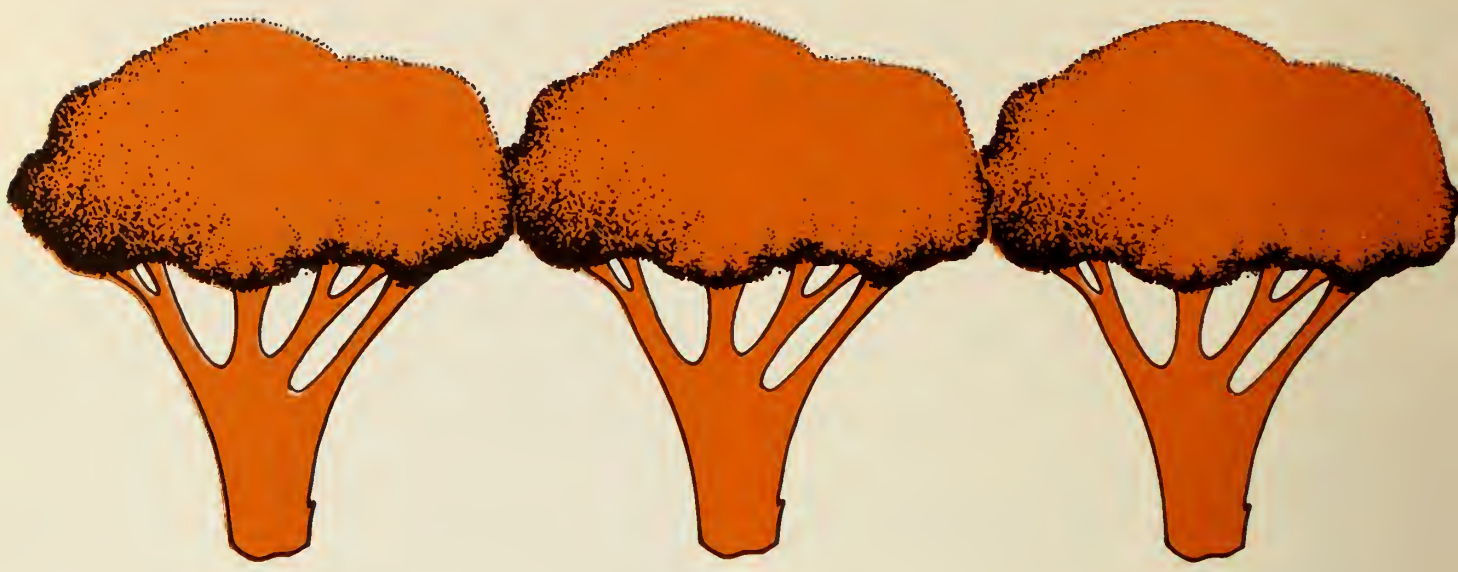
Generally, the objectives could provide for coordination of planning by federal and provincial governments, universities, producers, marketing and transportation agencies, processors, retailers and the consumer. All of these are components of the food system. Each member must be willing to state his objectives and priorities to facilitate the formation of relevant national priorities and objectives.

The systems-approach recognizes that many of the farm problems of today are "system" problems, and not those of agriculture alone. The goals and objectives of non-agricultural participants in the food system must be recognized if we are to maintain a healthy food system in Canada.

Under a market orientated approach it becomes the responsibility of each component to develop its objectives in consideration of, and hopefully in harmony with, the objectives of the total food system. Emphasis should be placed on identifying opportunities, producing and marketing for them, and on attempting to diminish conflicts which have become increasingly disruptive to agriculture.

As the Project '75 pilot study evolves, the development of a full program will emphasize a continuous examination of a total food system to identify potentials and constraints. Interaction between one commodity system and another will be stressed, and every effort will be made to fit individual systems into the overall aims and priorities that have been agreed upon for the benefit of the nation. ■

PRAIRIES SEE PROMISE OF MECHANIZED BROCCOLI PRODUCTION



G. H. GUBBELS

En cherchant les possibilités d'une mécanisation complète pour la production de brocoli, les scientifiques de la Station fédérale de recherches agricoles de Morden (Man.) ont sélectionné une variété de brocoli à petite pomme, appelée Harvester. Au cours d'essais en plein champ, cette variété a dépassé la production des variétés de brocoli à grosse pomme avec lesquelles elle avait été plantée. En plus de son rendement élevé, la variété Harvester arrive plus tôt à maturité, son cycle de végétation est court et uniforme, elle est d'une bonne grosseur et ne produit pas ces florules jaunes qui représentent souvent un problème avec les types de brocoli plus gros. Les recherches entreprises ont montré que la Harvester est la variété idéale pour la production mécanisée du brocoli.

Broccoli production can now be fully mechanized, from seeding to harvesting.

This fact emerged from a study conducted by us at CDA Research Station, Morden, Manitoba.

Dr. Gubbels is a special crops physiologist at CDA Research Station, Morden, Man.

At present, broccoli varieties grown in the Prairie Provinces lack uniformity of heading. A crop must therefore be harvested several times, at great expense for hand labor.

A type of broccoli that matures uniformly would be best suited to once-over mechanical harvesting. Such a variety would reduce hand labor and make it easier for farmers to schedule their planting, harvesting and processing operations.

Our investigations at Morden revealed considerable differences in uniformity of maturity among broccoli varieties. Harvester, a small-headed, high-yielding variety that produces well at dense plant populations, showed good promise of adapting to once-over mechanical harvesting.

FIRST EXPERIMENT

In 1969 we tried our first experiment, using four large-headed broccoli varieties, and the small-headed Harvester. (Table for 1969). On May 14, the seeds of the five broccoli varieties were sown directly into the field, in rows 39 inches apart. The four large varieties were thinned within the rows to a plant population of 8,465 an acre (about 19 inches apart). The fifth variety, Harvester, was thinned to about 2.5 inches apart, leaving 64,335 plants per acre.

FIVE BROCCOLI VARIETIES: HARVEST DURATION AND YIELD (1969)

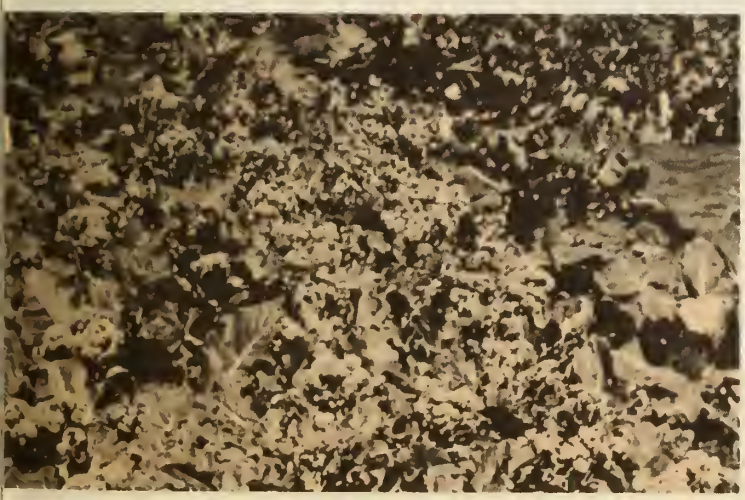
	Approx. duration of 90% harvest (days)	Yield (lb./acre)	Av. wt/head (oz.)
Atlantic	12	2766	7.5
Topper 430	17	3353	8.5
Coastal	11	2730	7.2
Gem Hybrid	9	3665	7.6
Harvester	4	3448	1.3

FOUR BROCCOLI VARIETIES: HARVEST DURATION AND YIELD (1970)

	Approx. duration of 90% harvest (days)	Yield (lb./acre)	Av. wt/head (oz.)
Coastal	12	3720	7.7
Waltham 29	27	5335	11.4
Gem Hybrid	6	4095	8.5
Harvester	9	14516	1.9
Harvester (once-over)		12937	2.0

Gem Hybrid broccoli.

Harvester broccoli.



Harvester was found to mature early, show uniformity of heading, produce a good stand and provide a yield comparable to that of the larger varieties used in the study. The entire Harvester crop was taken in three cuttings at three-day intervals. Eighty-four percent of the crop was taken in the first two cuttings.

Gem Hybrid was the most promising of the large-headed varieties. It withstood the wind well, reached maturity early with uniform heading, and gave a high yield.

SECOND EXPERIMENT

Encouraged by Harvester's uniformity in maturing, we attempted a second experiment with closer spacing, and a once-over harvest. For the 1970 season, we planted three large-headed varieties, including Gem Hybrid, along with the small-headed Harvester (Table for 1970). Our three control varieties were grown in the 1969 spacing pattern. Harvester, however, was grown in three-row plots, with rows only 13 inches apart. Plants within the rows were again thinned to 2.5 inches apart. But reduced distance between rows resulted in a plant population of 193,000 an acre.

Harvester was treated in two ways. Half the plots were cut as the heads matured. The other plots were cut in a simulated once-over harvest.

Results showed that Gem Hybrid matured earliest and had the shortest harvest period. Harvester matured next, had the second shortest harvest period and greatly out-yielded the three large-headed varieties.

Although the simulated once-over cropping method (compared to individual cutting), reduced yield by 11 percent, Harvester still out-produced all other varieties. When Harvester's once-over cut was graded, nine percent of the yield was found to be over-mature, 86 percent was at its prime and five percent was immature.

HARVESTER WINS

Gem Hybrid showed good maturing uniformity and produced large heads averaging 8.1 oz. Harvester, on the other hand, had small heads, averaging 1.6 oz. It tolerated high plant densities and produced far greater yields than the standard varieties grown in the tests at near-standard spacing.

Because of its small head, Harvester would require less sizing than the larger variety—a time-saving factor in processing and packaging on the production line. Again, the small-headed Harvester would eliminate another problem. Yellow florets, often found within large broccoli heads, would not create a problem in this variety.

Complete mechanization of broccoli production has therefore become an attractive possibility. ■

P. W. JOHNSON

Dans le sud de l'Ontario, la production des légumes de serres a atteint le chiffre brut d'environ 8 millions de dollars en 1971. Cependant, l'expansion future est menacée par le nématode cécidogène méridional. Des études effectuées à la Station fédérale de recherches agricoles de Harrow (Ont.) démontrent que les nématodes qui se trouvent à une profondeur supérieure à 40 pouces ne sont pas touchés par les méthodes actuelles de stérilisation des sols. Le rythme de reproduction élevé des nématodes et leur ascension dans le sol provoquent des problèmes périodiques d'infestation. Les chercheurs de Harrow proposent: de placer les fumigants à une plus grande profondeur; d'épandre des nématocides endothérapiques (systémiques); de mettre au point des variétés résistantes de légumes. Si ces trois propositions se réalisent, la production des serres pourra être augmentée à un coût moindre.

IN SOUTHWESTERN ONTARIO'S GREENHOUSES ROOT-KNOT NEMATODE PLAGUES TOMATO AND CUCUMBER CROPS

The Southern Root-Knot nematode has been making serious inroads into Southern Ontario's expanding greenhouse vegetable industry which grossed approximately $8 million in 1971. In the Essex county area, there are 245 acres of vegetables under glass with an additional 82 acres under plastic.

Tomatoes and cucumbers are the most important greenhouse vegetable crops of the industry. Usually, two crops a year are grown, with tomatoes and cucumbers frequently rotated. Both tomatoes and cucumbers are highly susceptible to Southern Root-Knot nematode *Melodogyne incognita* (Kofoid & White, 1919) Chitwood, 1949, and most vegetable growers are only too familiar with the knotted, galled appearance of the roots of infested plants.

Harrow Research Station conducted a survey of 50 Essex county greenhouse operations in 1969. The survey revealed considerable nematode infestation in 42 per cent of the houses sampled. Sampling procedure was not designed to detect low levels of infestation, so we could assume that the actual proportion of infested houses was probably higher than the figure shown. Our assumption was supported by croppers' observations of spotty infestation in houses where the presence of Southern Root-Knot nematode had not been detected by the survey.

EXPENSIVE TREATMENT

Treatment histories of the houses sampled showed that 88 per cent of the growers, in addition to steaming, had applied a nematocide at least once in the past three years, and that 48 per cent had applied a nematocide every year. Chemical treatment is expensive, and can represent a large proportion of production costs in this highly competitive business.

Although the Southern Root-Knot nematode has a high reproduction rate, an initial low population at planting-time will cause little apparent loss to the first crop. However, if control measures are not applied after harvesting, devastating losses will occur in the second crop.

The recurring nature of the problem has usually been attributed to poor control practices. Recent findings at the Harrow Station indicate a different reason: in greenhouses with recurring nematode problems, a series of soil samples were taken prior to planting each of the last three tomato crops. Samples were taken at five-inch increments, to a soil depth of five feet. Nematodes were found in substantial numbers of all depths.

After the soil tests had been made, the soil was sterilized by steam, nematocide, or a combination of both. The soil was again tested, and we found that regardless of the sterilization treatment employed, nematodes below the 40-inch depth of soil were not affected.

Dr. Johnson is a nematologist at the CDA Research Station, Harrow, Ont.

Dr. Johnson uses soil auger to take deep soil sample for nematodes in a cucumber greenhouse.

(Top left) Meloidogyne incognita *galls on roots of tomato plant.*

(Center left) Female M. incognita *embedded in galled tomato root*

(Bottom left) To measure vertical movement of nematodes in greenhouse, tomato plants are planted in microplots six inches in diameter and five feet deep.

QUICK BUILD-UP

During the growth of the crop planted subsequent to each sterilization program, we found the nematode population quickly building up to damaging levels at all soil depths. Apparently, nematodes below the 40-inch depth escape control and quickly move upwards to infest the newly planted crop. The vertical movement of the pests explains the short term effect of control measures, and accounts for the recurring problem of infestation.

Three measures are being studied in an attempt to develop controls effective for more than one cropping period. The possibilities are: deeper placement of fumigants; application of systemic nematocides; development of resistant varieties of tomatoes and cucumbers.

If these measures fail, growers may be forced to shift to the more expensive soilless culture. A program of effective control for Root-Knot nematode in greenhouse vegetables would mean increased production at lower cost for greenhouse operators. ■

ECHOES
FROM THE FIELD AND LAB

ECHOS
DES LABOS ET D'AILLEURS

PESTICIDE POLLUTION *Meteorological Aspects of Pollution in Relation to Agricultural Pesticides* is the title of a new booklet published by the Research Branch of Canada Department of Agriculture. A series of position papers, the booklet deals with various phases of pesticide transport in the atmospheric cycle. It represents an attempt to define the state of current knowledge about pesticide pollution, and to probe areas where more information is needed. Coordinated and edited by J. T. Bergsteinsson and W. Baier, the booklet is listed in the Selected Canadian Agrometeorological Publications, under reference number: SCAP 54.1. It is available only from the Information Division, Canada Department of Agriculture, Ottawa, Ont., K1A 0C7.

SCOTTISH FAIRS A Canadian livestock man at a Scottish livestock fair, is impressed by: the portable nature of the two-day event—all tents and individual livestock trailers—no permanent buildings; the enthusiasm of some 45,000 people attending the fair; the remarkable cleanliness of the site—no litterbugs; the total independence of farmers, breeders and organizers of the fair—no government assistance. Above all, there is no carnival atmosphere.

"Canadians can learn a great deal from the Scottish farmer" said J. Harvey Cochran, on his return from a quick trip to Scotland made at the invitation of the Scottish Ayrshire Breeders Association. Mr. Cochran is Chief of Markets and Merchandising, Livestock Division, Canada Department of Agriculture, Ottawa. In Scotland he was struck by another fact: there is no compulsory pasteurization of milk, therefore strict sanitation measures are observed for stabling and milking cows, and dairy herds must be certified free from tuberculosis and bangs.

BEEF CARCASS RATING A great hit with beef producers across Canada is the new Beef Carcass Appraisal Service, introduced Jan. 10, by the federal government. Administered by Canada Department of Agriculture's Livestock Division, the service provides each participating beef producer with detailed carcass information after his animal has been slaughtered. A special ear tag, distinctive in color and design, is produced from CDA and attached to a selected animal. When the animal is slaughtered, the tag is removed from the ear and affixed to the carcass by the federal meat inspector; carcass grade-out data provided by federal livestock graders at the meat processing plant is then relayed by CDA to the tag purchaser. Data provided by the service includes; warm carcass weight, quality, grade, area of rib-eye and fat measurement. This information can be used by producers to evaluate breeding, feeding and management programs. in the first seven months of operation about 7,500 animals entered in the program were supplied with CDA ear tags. By mid-July, cutout results from 1,366 carcasses had been mailed to beef producers.

RYE GOES TO THE COWS Rye grain grown in Canada has traditionally headed for the distilling industry. Dairy cattle could consume more if the price was right.

Canadian farmers grew slightly more than one million acres of rye in 1970, with the Prairies producing 94 percent of that crop. But winter rye is also a reliable crop in some areas of the Maritimes.

"Dairy cattle do very well on a diet of 60 percent or more of rye in their grain mixture", says Dr. Paul L. Burgess, dairy cattle nutritionist at the Canada Department of Agriculture Research Station, Fredericton, N.B. Dr. Burgess recently completed a three-month study of feeding standards for dairy cattle. He found that the previously recommended 40 percent of rye in dairy cattle rations could be increased by at least 20 percent.

FRUIT STORAGE Two scientists of Britain's East Mailing Research Station have compiled a comprehensive little booklet on the handling and storage of apples and pears.

Entitled, *Refrigerated Storage of Apples and Pears - A Practical Guide,* the booklet has graphs and well illustrated descriptions of harvesting, storage, refrigeration, controlled atmosphere stores, maintenance and operations, and physiological disorders resulting from inadequate handling of the fruit.

J. C. Fidler and G. Mann are author-editors of the booklet which is available from the publishers: Commonwealth Agricultural Bureaux, Central Sales, Farnham Royal, Slough SL2 3BN, England.

FRESH CEREAL Sealed metal drums that keep cereals fresh for months, have been developed with Canadian assistance to help farmers in Senegal preserve stocks between harvests.

Previously, primitive containers were made of mud, straw or wood, and failed to protect foodstuffs from rats, birds, insects, bacteria and the tropical climate. Food losses were running to about 30 percent, and increased production of about 42 million tons of cereal a year by 1975 appeared the only solution.

On the basis of a study by an expert of the Food and Agriculture Organization of the United Nations, a pilot project to remedy the situation was established by Canada + 1, so named because it was founded a year after Canada's Centenary in 1967. The organization is made up of representatives from companies advanced in food technology. Financial support for the project came from the Canadian International Development Agency.

Two thousand drums, displaying Canada's flag, were distributed to farmers in Senegal who were taught the value of the drums and how to fill and seal them.

The Government of Senegal is now following up the project by making metal drums, and the necessary instruction, available to all farmers. Other African states are also adopting the idea of preserving harvested crops in air-tight drums.

With reference to the article "Nematodes—a Limiting Factor in Forage Production", by J. L. Townshend, J W Potter, J. Santerre and C B Willis (Canada Agriculture, Summer, 1972, pages 19-23), the scientific name for the root-lesion nematode was misspelled as *"Paratylenchus penetrans"*, it should have read throughout the article as *"Pratylenchus penetrans"*

THE EFFECT OF LONG TERM CREDIT ON FINANCIAL PERFORMANCE OF CANADIAN FARMS

A. H. HARRISON

Le crédit agricole joue un rôle important dans le financement des entreprises agricoles. La Société du crédit agricole, principal pourvoyeur de crédit à long terme, a contribué, par ses prêts, au développement agricole. En 1969, la SCA a fait une étude des progrès réalisés par les agriculteurs qui avaient obtenu des prêts dans le cadre de la Loi sur le crédit agricole. Les résultats ont indiqué que la plupart des emprunteurs de la SCA avaient progressé de façon satisfaisante, mais que sur près de 1,300 emprunteurs agricoles au Canada, 208 avaient encore des dettes au moment de l'enquête. Bien qu'on ne puisse éliminer tous les arrérages, les résultats indiquent selon la SCA, qu'avant d'effectuer un prêt, plus de réalisme doit être apporté à évaluer les possibilités de remboursement et à aider l'emprunteur par de meilleures méthodes de planification agricole.

Farm credit has played, and no doubt will continue to play, an important role in financing farm businesses. The trend towards larger, more highly mechanized and capital intensive farms has been a contributing factor in the increased use of long-term credit.

The Farm Credit Corporation, as the main supplier of long-term credit, has shared in the general trend towards greater use of external financing to facilitate farm development. In 1965-66 the Corporation had $586 million outstanding to 52,900 farm businesses. By 1968-69 the amount of loans outstanding had increased to slightly over $1 billion with 67,100 farm borrowers.

Limited research has been done in the past to examine the impact of credit on the financial performance of farm borrowers. A study of this nature was carried out, however, by the Farm Credit Corporation in 1969. Specific objectives were to investigate, analyze and measure the progress attained by farm operators who had received loans under the Farm

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Credit Act. The survey was regarded as an important means of providing a feedback of information and a necessary aid for assessing future lending policy and programs.

METHODOLOGY

The sample selected for the farm survey consisted of 1,294 F.C.C. borrowers who had received Part II loans under the Farm Credit Act during the fiscal year 1965-66. Part II loans carried a maximum of $40,000[1] to an individual farmer, partnership or family corporation and were secured entirely by farm real estate. The 1,294 loans were randomly selected from all provinces except Newfoundland and the sample represented one-seventh of all loans made during the 1965-66 fiscal year.

The quality of the survey sample was judged on the degree of comparability in capital structure between sample farms and all farms receiving loans in the fiscal year 1965-66. The average value of real estate, livestock, equipment and liabilities was compared through calculating standard errors and determining the degree of statistical significance of any differences. While some differences did exist for some provinces, on a national basis the sample was considered representative of all loans made during 1965-66.

In order to assess the relative progress achieved by F.C.C. borrowers it was necessary to examine the performance achieved by all commercial farms.[2] Although F.C.C. borrowers are included in the statistics gathered on commercial farms it was considered valid to compare the average progress of the F.C.C. survey group against the average for all commercial farms. It was assumed that any differences in performance could be attributed in part to the use of long-term credit. It was recognized that such a comparison has limitations, in that the commercial averages are influenced by a percentage of relatively small farms and very large farms both of which are dissimilar to the average F.C.C. borrower. In addition the commercial average would be influenced by the inclusion of all F.C.C. borrowers. Thus, if the survey sample outperformed all commercial farms, the differences would likely be underestimated.

RESULTS

Tables I to *IV* have been prepared to summarize the highlights of the study. In general the analysis considered the growth of capital, and income generation as the main criteria for measuring financial progress. The changes observed over the four-year period were compared to the changes observed for all commercial farms.

Table I indicates the growth that occurred in average farm investment for both F.C.C. farms and all commercial farms. The percentage change in farm investment for F.C.C. borrowers exceeded that for all commercial farms in all provinces between 1965 and 1969. On a national basis, F.C.C. borrowers increased farm investment by 45.2 percent compared to 26.4 percent for commercial farms. It should be noted that 1965 investment for F.C.C. farms included the new capital added by the F.C.C. loan.

The average 1965 investment of F.C.C. borrowers was lower than the commercial averages in B.C., Alberta and Manitoba, while it was slightly larger in all other provinces.

In 1969 the average farm investment of F.C.C. borrowers was larger than the commercial averages in all provinces, particularly in Quebec and the Maritimes.

The figures in *Table II* attempt to portray the real growth of farm investment in constant prices after removing the effect of inflation. For each group the percent change in farm investment in current prices was obtained from *Table I*. The inflation index was determined from a weighted average reflecting changes in per acre values of farm real estate and price changes in farm machinery. No price change was assumed for livestock during the period.

POSITIVE CHANGES

For all F.C.C. farms the change in average farm investment in real terms was estimated to be 14.7 percent compared to a slight decrease of −0.2 percent for all commercial farms. While F.C.C. farms in all provinces indicated positive changes in real capital, only commercial farms in the three Prairie Provinces and Nova Scotia had similar changes. The increased withdrawal of valuable agricultural land for non-farm uses may in part explain the low rate of real capital growth in some provinces.

Table III examines the farm debt structure of the F.C.C. group and its comparison to be estimated average debt of all commercial farms. The average debt for commercial farms was estimated from the total interest paid on farm debt as reported by Statistics Canada. The proportion of total interest charges allotted to commercial farms was equated with the proportion of total farm capital represented by commercial farms. Average interest rates were obtained from estimates reported in *Canadian Farm Economics*.[3] While this method may underestimate the average debt of commercial farms in some provinces, it does provide a reasonable approximation.

Table III shows that in 1965 the average farm debt (after loan) of F.C.C. borrowers was $24,945, or 2.7 times greater than the $9,212 average for commercial farms. Four years later the average debt of F.C.C. borrowers had increased by 24.5 percent to $30,945.

[1] Loans up to $100,000 are now available under Part II of the Farm Credit Act.

[2] data obtained from Statistics Canada.

[3] Source: Rust, R. S., Canadian Farm Economics, August 1971.

This was 2.4 times larger than the estimated average commercial farm debt of $12,639. In spite of their increased indebtedness, F.C.C. borrowers increased their equity from 58.1 percent in 1965 to 64.2 percent in 1969. The average equity position of all commercial farms decreased slightly from 83.1 percent in 1965 to 81.7 in 1969.

GROWTH IMPETUS

Generally the figures in *Table III* indicate that the initial long-term credit obtained by F.C.C. borrowers provided an impetus for a higher level of growth than was achieved by farmers without similar credit.

The changes in average returns to labor, management and capital (LMC) for F.C.C. farms and all commercial farms are compared in *Table IV*. Income data is for 1964 and 1968 which represents the annual income preceding the year of loan (1965) and the year of farm survey (1969). It is noted that the average L.M.C. for F.C.C. farms in 1964 was below the commercial averages in the four western provinces and above the commercial average in the eastern provinces. By 1968 the average L.M.C. for the F.C.C. sample was below the commercial averages in only two provinces, B.C. and Saskatchewan.

The percent change over the two time-periods was higher for F.C.C. borrowers in all provinces except Nova Scotia.

For Canada as a whole, F.C.C. farms improved their net returns by 66.6 percent compared to an increase of 30.5 percent for commercial farms. While there was some lessening of net incomes in the Maritimes, on the whole the use of long-term credit would appear to have contributed to minimizing this development.

TABLE 1. CHANGES IN AVERAGE FARM INVESTMENT
F.C.C. BORROWERS[1] (FARM SURVEY) AND ALL COMMERCIAL FARMS, 1965, 1969

	Farm Survey				Commercial Farms				
Province	No. of Farms[2]	Farm Investment 1965[3]	Farm Investment 1969	% Change	No. of Farms 1965	Av. Farm Investment 1965[3]	No. of Farms 1969	Av. Farm Investment 1969	% Change in Farm Inventory
British Columbia	67	$61,613	$95,277	54.6	8,350	$73,291	8,510	$92,666	26.4
Alberta	349	65,701	96,198	46.4	48,200	71,384	51,500	89,634	25.6
Saskatchewan	378	66,266	90,320	36.3	68,680	59,602	73,812	79,511	33.4
Manitoba	116	52,059	79,607	52.9	26,750	53,097	29,210	66,573	25.4
Ontario	241	55,905	86,737	55.1	70,500	49,776	71,362	65,765	32.1
Quebec	104	37,269	51,430	38.0	41,350	29,824	43,788	34,771	16.6
New Brunswick	13	33,186	41,984	26.5	2,960	29,236	2,853	36,035	23.2
Nova Scotia	6	36,832	49,130	33.4	2,900	30,526	2,780	38,330	25.6
Prince Edward Is.	20	28,145	57,750	105.2	3,240	27,231	3,600	33,022	21.3
Canada	1,294	59,526	86,447	45.2	273,275	54,689	287,510	69,131	26.4

[1]Farm Investment for F.C.C. Borrowers in 1965 included New Capital added by F.C.C. loan.
[2]Farm Survey sample included approximately 14% of loans made in 1965-66 fiscal year.
[3]Includes Real Estate, Livestock and Equipment (Data for commercial farms obtained from Statistics Canada).

TABLE 2. REAL CHANGES IN FARM INVESTMENT PER FARM
F.C.C. FARMS AND COMMERCIAL FARMS, 1965 AND 1969

	F.C.C. Survey Farms			All Commercial Farms		
Province	% Change in Farm Investment (Current Dollars)	Inflation Index[1]	% Change in Real Capital	% Change in Farm Investment (Current Dollars)	Inflation Index[1]	% Change in Real Capital
British Columbia	54.6	132.5	16.7	26.4	132.5	—4.7
Alberta	46.4	125.4	16.7	25.6	125.4	0.1
Saskatchewan	36.3	113.6	19.9	33.4	113.6	17.4
Manitoba	52.9	117.1	30.6	25.4	117.1	7.1
Ontario	55.1	150.4	3.1	32.1	150.4	—12.2
Quebec	38.0	118.2	16.7	16.6	118.2	—1.4
New Brunswick	26.5	123.9	1.2	23.2	123.9	—0.5
Nova Scotia	33.4	120.8	10.4	25.6	120.8	4.0
Prince Edward Island	105.2	124.5	84.5	21.3	124.5	—2.6
Canada	45.2	126.6	14.7	26.4	126.6	—0.2

[1]Inflation Index was determined by using Index of Land Values (Farm Credit and Related Statistics, p.37) and appropriately weighted to reflect the proportion of total farm investment held in real estate. The Index of Farm Machinery Prices was used to determine the price change in machinery. No price change was assumed for livestock. An overall price change (%) was calculated to reflect the inflationary effect on total farm investment. 1965 prices = 100.

TABLE 3. FARM DEBT AND OWNED FARM INVESTMENT[1]
FARM SURVEY AND ALL COMMERCIAL FARMS, 1965, 1969

Province	F.C.C. Farms (Farm Survey)							All Commercial Farms[2]						
	1965 Farm Debt	1969 Farm Debt	1965 Owned Farm Invest.	% Equity	1969 Owned Farm Inv.	% Equity	% Change Owned Inv.	1965 Farm Debt	1969 Farm Debt	1965 Owned Farm Inv.	% Equity	1969 Owned Farm Inv.	% Equity	% Change Owned Inv.
B.C.	$29,540	$36,230	$32,073	52.1	$59,047	61.9	84.1	$ 9,914	$12,921	$63,377	86.5	$79,745	86.0	25.8
Alta.	26,280	33,570	39,421	60.0	62,628	65.1	59.9	10,461	14,609	60,923	85.3	75,025	83.7	23.1
Sask.	23,320	27,870	42,946	64.8	62,450	69.1	45.4	9,782	13,688	49,820	83.6	65,823	82.8	32.1
Man.	22,250	30,160	29,809	57.3	49,447	62.1	65.9	8,490	11,588	44,607	84.0	54,985	82.6	23.3
Ont.	29,300	34,350	26,605	47.6	52,387	60.4	96.9	8,041	11,558	41,735	83.8	54,207	82.4	29.9
Que.	21,058	26,520	16,211	43.5	24,910	48.4	53.7	7,810	10,616	22,014	73.8	24,155	69.5	9.7
N.B.	24,045	19,170	9,141	27.5	22,814	54.3	149.6	5,727	8,821	23,509	80.4	27,214	70.9	15.7
N.S.	16,330	23,060	20,502	55.7	26,070	53.6	27.1	5,259	8,050	25,267	82.8	30,280	78.9	19.8
P.E.I.	14,030	23,880	14,115	50.1	33,870	58.6	139.9	6,963	9,405	20,268	74.4	23,617	71.5	16.5
Canada	24,945	30,945	34,581	58.1	55,502	64.2	60.5	9,212	12,639	45,477	83.1	56,492	81.7	24.2

[1]Farm Investment only includes current value of real estate, livestock and equipment and compares with that used by Census data.
[2]Debt of commercial farms estimated by using average interest rate on debt (See Farm Credit and Related Statistics, 1971, p.29) and amount of interest paid as reported by Statistics Canada in Farm Net Income. The proportion represented by commercial farms was equated to the proportion of total farm capital.

TABLE 4. GROWTH IN L.M.C., 1964, 1968
F.C.C. FARMS AND COMMERCIAL FARMS

Province	F.C.C. Survey Farms			All Commercial Farms[1]		
	Average L.M.C. 1964	Average L.M.C. 1968	% Change	Average L.M.C.[2] 1964	Average L.M.C.[2] 1968	% Change
British Columbia	$3,510	$7,855	137.8	$6,258	$8,514	36.0
Alberta	3,252	6,798	109.0	4,395	6,411	45.9
Saskatchewan	4,234	5,778	36.4	4,565	5,864	28.4
Manitoba	3,164	5,703	80.2	5,280	4,894	−7.4
Ontario	3,984	6,221	56.1	2,951	3,720	26.0
Quebec	3,145	6,393	103.3	1,973	3,621	83.5
New Brunswick	4,254	3,958	−7.0	3,918	2,402	−38.7
Nova Scotia	6,066	5,620	−7.4	2,921	4,230	44.8
Prince Edward Island	4,620	4,030	−12.8	2,752	1,529	−44.5
Canada	3,755	6,256	66.6	3,794	4,953	30.5

[1]It was assumed that 95% of total L.M.C. accrues to Commercial Farms.
[2]Interest excluded from expenses to calculate L.M.C. for Commercial Farms.

It should be pointed out that farm income is often subject to wide fluctuations and any conclusions reached on the basis of comparing only two time-periods must be interpreted with caution.

SUMMARY

While the aggregate results indicated that F.C.C. farm borrowers achieved a satisfactory degree of performance, there were certain classes of farm borrowers within the survey sample that did not achieve similar results. It was found that 208 of the farm borrowers were in arrears at the time of the 1969 survey and many of these experienced little or no growth since 1965. It was also found that on a national basis those farms with a total investment of less than $70,000 lost ground, relative to the farm industry. Unless the economic efficiency of these small scale operations improves considerably, long-term credit must be viewed as a very temporary solution to their economic problems. Although it is argued that arrears cannot be totally eliminated, survey results pointed to a greater need of farm planning, and of repayment assessment at the time of loan consideration.

With respect to long-term trends, economic pressures still exist for the continued increase in long-term investment for both expansion and technological development of farm businesses. The same pressures also indicate the need for larger and improved supplies of short- and intermediate-term credit. Adequate quantities and qualities of all forms of farm credit are necessary to ensure satisfactory growth of viable farm businesses. This imposes a requirement on all suppliers of farm investment capital to provide increasingly improved and coordinated services. ■

SILAGE CORN PRODUCTION IN THE SOUTHERN INTERIOR OF BRITISH COLUMBIA

WILLIAM A. HUBBARD

La production de maïs d'ensilage a augmenté d'une façon extraordinaire dans la partie sud de la Colombie-Britannique intérieure. Les variétés supérieures hybrides de maïs lancées au cours des dix dernières années en sont la cause. L'auteur affirme que le choix du maïs hybride le mieux adapté aux unités thermiques (degrés-jours) disponibles dans une région est de la plus haute importance si l'on veut obtenir des rendements d'ensilage élevés. L'irrigation, et les régions septentrionales produisant du maïs d'ensilage à haute teneur en grain sont deux facteurs de production caractéristiques en Colombie-Britannique.

Corn grown for ensilage in British Columbia has been given a new lease on life by the introduction of superior hybrid varieties. During the last decade, there has been a dramatic increase of silage corn production in the southern interior of the province. Over 7,000 acres are grown in the interior; a similar acreage is now grown in the lower Fraser valley.

Although many areas yield only 10 or 12 tons of silage per acre, it is reasonable to strive for 25-30 tons per acre in the corn-growing areas where the heat units are available.

There is really nothing magic about high silage yields. The first step is to plant a high-yielding hybrid. The best hybrids for silage are those that produce high grain yields. Half the dry weight, and two-thirds of the total digestible nutrients (TDN), of the corn plant are contained in the ear. Thus, silage with a high grain-to-forage ratio is more digestible, and more efficiently utilized by livestock. The varieties recommended for growing in British Columbia are published each year by the B.C. Corn Committee (Table shows the 1972 recommended varieties).

PLANT EARLY

In this province, corn for ensilage should be planted as early as possible. This means before May 1, and certainly not later than May 15. A planting rate of 32,000, preferably in 28-inch rows, is needed to give a population of 26,000–28,000 plants per acre.

It is generally accepted that a 30-ton crop of corn silage will remove 200 lb of nitrogen (N), 80 lb of phosphorus (P_2O_5) and 240 lb of potash (K_2O) from the soil. For maximum yields, soil tests should be obtained and fertilizer applied to supply crop needs for the current season.

In the interior of British Columbia, there are few areas where corn can be grown without additional

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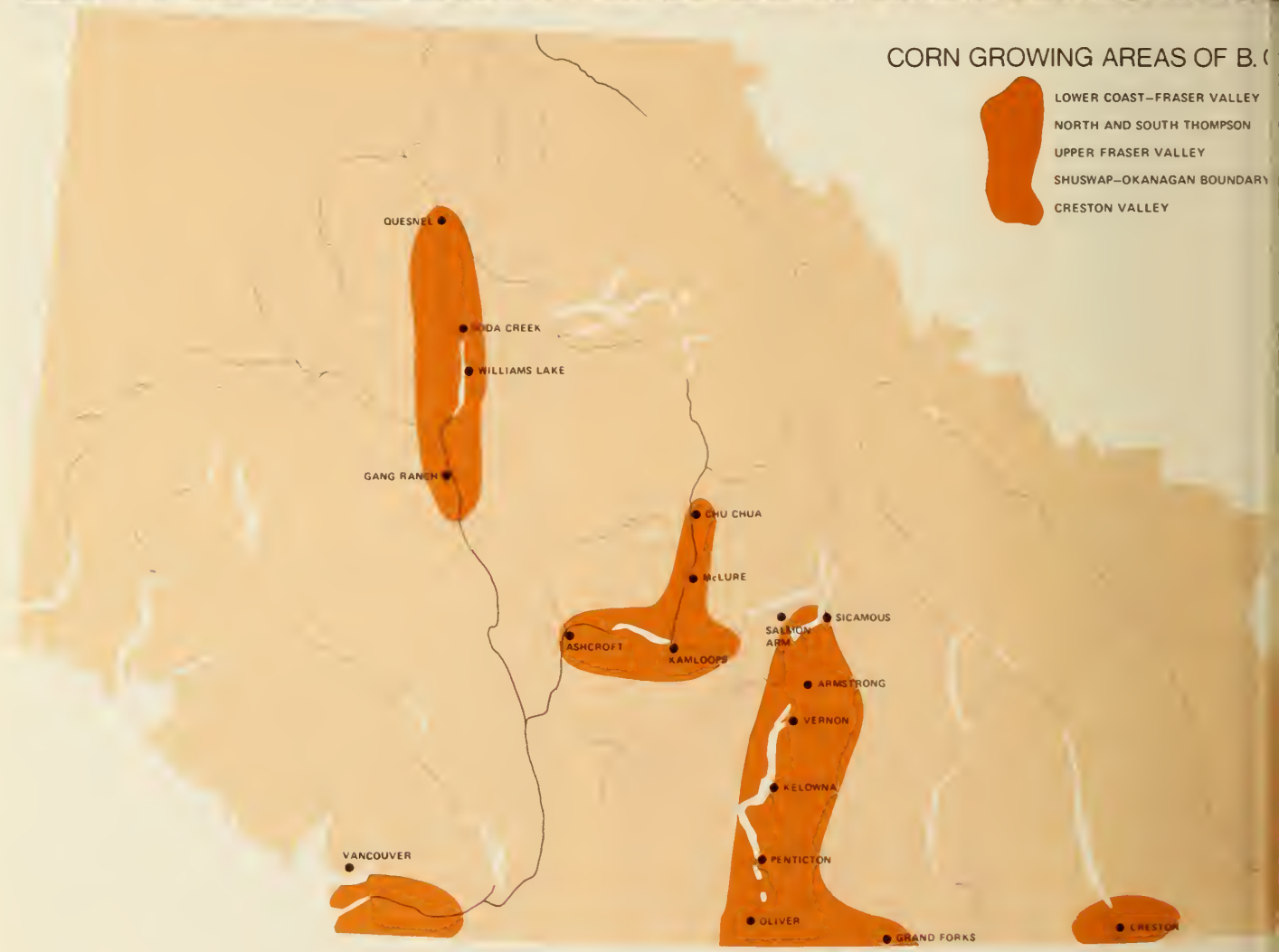
CORN GROWING AREAS OF B.
LOWER COAST–FRASER VALLEY
NORTH AND SOUTH THOMPSON
UPPER FRASER VALLEY
SHUSWAP–OKANAGAN BOUNDARY
CRESTON VALLEY
QUESNEL
WILLIAMS LAKE
GANG RANCH
CHU CHUA
McLURE
ASHCROFT
KAMLOOPS
SICAMOUS
SALMON ARM
ARMSTRONG
VERNON
KELOWNA
PENTICTON
OLIVER
GRAND FORKS
CRESTON
VANCOUVER

(Left) Wide rows in B.C. silage corn allow for irrigation.

(Above) Harvesting corn for silage in B.C.'s northerly climate.

FIELD CORN: HYBRIDS GROWN IN B.C.

Corn Heat Units (CHU)	Varieties
Very Early- under 2,600 CHU	NK 410 Idahybrid 216 Pride 116 Warwick 209 De Kalb 22 Bell River 14
Early- 2,600-2,750 CHU	PAG 47 Pioneer 3872 Warwick 261 Warwick 263 United Hagie 106 Pioneer 3862 UH 4 Wheatland Blend PAG SX 42 Pride 116 (trial)
Medium- 2,800-2,900 CHU	De Kalb 15A De Kalb 45 Pride 20 Pride 137 Pioneer 388 Warwick 401
Late- Over 2,900 CHU	Idahybrid 330 Pioneer 368A Pioneer 3773 Pioneer 3873

moisture. This means that approximately 2½ acre-feet of water must be supplied by irrigation during the season. It is extremely important to see that the plant is under no stress for moisture, from the time it starts to tassel until the silking period is over.

HARVEST TIME

Knowing when to harvest is also important. It is a mistake to cut corn too early since ears become a larger portion of the total plant dry matter as the corn matures. Most nutrients are produced during the latter stages of kernel growth. In addition, digestibility of leaves and stalks decreases comparatively little as corn matures. Other advantages of waiting include: higher dry matter intake by livestock when the moisture is lower; lower dry matter losses through seepage from the silo; less water hauled from the field to the silo. If the silage is to be fed to calves or yearlings it is preferable that the dry matter content be 32%. These animals normally consume 30 to 40 lb of silage a day, so the dry matter intake would be seriously reduced if the silage is very wet.

It has been found at the CDA Research Station, Kamloops, that the best time to harvest corn for ensilage is when the kernels are well dented and the plant's lower leaves are turning brown. If these recommendations are followed, it is possible to ensile a highly nutritious crop that will contain 25 to 35% dry matter. The crop should be cut with a field chopper that is capable of cutting into lengths from half to three-quarter inch.

ADD PROTEIN

Corn is easily ensiled and requires no preservatives. However, as corn has only about 8.1% protein, it may be desirable to add 10 lb of feed-grade urea per ton of material put into the silo. The urea should be added only after the first five feet of chopped corn have been placed in the bottom of the silo. This will increase the protein content to a level suitable for most classes of beef cattle. Silage made this way has been fed to 500 lb calves as a sole diet during the winter months. Average daily gains of up to 1½ lb per head per day have been obtained. Calculated beef yields averaged 1,450 lb per acre, on a production of seven tons of dry matter per acre. However, it is desirable to have some high quality hay on hand which can be fed to the animals. During extremely cold weather silage may freeze before the animals have a chance to eat it.

Preliminary research indicates that even greater gains than those noted above may be expected if finely ground alfalfa is added to corn silage fed. This is especially true if the silage is very wet (18 to 24% dry matter). The ground alfalfa absorbs excess moisture and consequently increases the daily dry matter intake of the animals being fed. ■

SOIL COMPACTION REDUCES POTATO YIELDS

G. R. SAINI and D. A. HUGHES

Les pédologues savent depuis longtemps que le tassement du sol compromet gravement la croissance des plantes. L'intensification de la mécanisation des exploitations et la monoculture ont augmenté le tassement du sol et réduit les rendements dans les régions de culture de pommes de terre du Nouveau-Brunswick. Même si les pédologues ont analysé les causes qui provoquent le tassement, ils continuent de chercher une solution à ce problème.

Soil scientists have long known that soil compaction creates a series of limitations to plant growth. Severe packing results in the deterioration of certain desirable physical characteristics of the soil. In turn, this physical deterioration reduces aeration in the root zone of plants growing in such soil. Because of the mechanical obstruction, roots are unable to penetrate soil spaces, and cannot absorb nutrients that may be present in abundance.

The recent rapid increase in mechanized field operations, the weight of individual machines, and the practice of continuous potato cropping on the same fields, have combined to increase soil compaction in New Brunswick's Upper Saint John River Valley. Perhaps compaction has already put the squeeze on profits, for potato growers in the area.

From CDA's Research Station in Fredericton, we studied the effect of compaction on potato yield, its effect on oxygen diffusion rates and moisture movement, and the compactibility of potato-growing soils.

Here we present some of our observations.

Dr. Saini is a specialist in soil physics and Mr. Hughes is a technician at the CDA Research Station, Fredericton, N.B.

COMPACTION MEASUREMENT

Soil is a porous medium composed of solid particles, and of spaces filled with air and water. Compression of the soil forces the solid particles together and squeezes out the water and air that are both essential to plant growth. The extent of soil compaction is specified by bulk density (D_b), which is actually the weight of dry soil per unit volume.

A cubic foot of freshly ploughed dry soil weighs about the same as a cubic foot of water, or 62½ pounds. When this soil is compressed, one cubic foot weighs about 1.3 to 1.4 times as much as an equal volume of water. Bulk density (D_d) measurements of soil samples taken with a core sampler in the field are, therefore, used as a criterion of compaction. The higher the D_b of the soil sample, the more compact the soil. Stones in the potato soils of New Brunswick, however, pose some problems in making comparisons of D_b. We, therefore, have to make corrections in our D_b determinations for stones in the sample. Thus, our D_b values seem to be lower than the ones reported in literature pertaining to soils elsewhere.

EFFECT ON POTATO YIELD

In order to determine the effect of compaction on the physical properties of certain soils, and on potato yields, we conducted field experiments at four locations in the Upper Saint John River Valley: two on Holmesville soil; one on Caribou soil; one on Monquart soil. Soil compaction in these experiments was induced by varying intensities of tractor traffic between plant rows.

As the number of tractor-passes increased from 0 to 12, D_b increased from 0.99 to 1.17 grams per cubic centimeter (g/cm^3) and the oxygen (O_2) diffusion

TABLE 1. EFFECT OF TRAFFIC ON SOIL PHYSICAL PROPERTIES AND POTATO YIELDS

Tractor passes	D_b (g/cm^3)	O_2 diffusion rate (g cm^{-2} min^{-1} x 10^{-8})	Soil water potential (bars) 4" depth	6" depth	Marketable tuber yield cwt/acre
0	0.99	67.96	20.4	19.7	251.0
3	1.06	67.58			217.0
6	1.08	67.58			213.0
12	1.17	58.94	10.4	22.8	197.0

TABLE 2. COMPACTIBILITY OF SOIL SERIES

Soil series	Bulk density Before growing season (g/cm^3)	After growing season (g/cm^3)	Increase %
Holmesville	1.11	1.21	9.0
Monquart	1.13	1.25	10.6
Caribou	1.02	1.20	17.6

(Opposite page) The weight of modern machines, and continuous cropping of some fields have contributed to compaction of potato soils.

(Above) Instrument measures rate of oxygen diffusion in a soil subject to compaction.

A potentiometric psychrometer measures soil moisture potential, or the tension at which water is held in the soil after rain.

rate was reduced from 67.96 X 10^{-8}, to 58.94 X 10^{-8} g cm^{-2} min^{-1}. *(Table 1).* The tension at which water was held in the soil after rain, was measured by a potentiometric psychrometer at four and six inch depths. These measurements showed *(Table 1)* that infiltration rate had decreased in plots where 12 tractor-passes had been made. Consequently, there would be more runoff from the surface of the soil, and less moisture content in the root zone of plants.

The overall effect of these changes was reflected in reduction of potato yields by as much as 54 hundredweight an acre (cwt/acre).

SOIL TYPE AND MOISTURE

During our investigations we also compared the compactibility of the three important potato growing soils previously named: Holmesville, Monquart and Caribou. We followed bulk density changes in the traffic rows of a number of fields, as normal operations were carried on by farmers during the growing season.

A summary of results given in *Table 2* shows that with normal operations over the growing season, Caribou soil tends to compact more easily (17.6% increase in D_b), than Monquart (10.6% increase in D_b), or Holmesville (9.0% increase in D_b). Collected data also reveal that the longer a field has been in continuous potato production, the more easily it tends to compact from the weight of machinery.

Not only does compaction vary according to soil type, but with soil moisture also. Moisture content at the time machinery goes on the field is very important.

Our laboratory study on Holmesville soil showed that pressure of 21 pounds per square inch (psi) gave a D_b reading of 1.11 g/cm^3 when the soil contained about 10 percent moisture. The same pressure increased D_b to 1.24 g/cm^3 when the soil contained about 40 percent moisture.

Experience has already made most farmers aware of the phenomenon of increased compactibility when the soil is moist or wet. Unfortunately, most heavy farm equipment has to be used for harvesting when soil conditions are most conducive to compaction.

NO EASY SOLUTION

Although it appears to be a relatively simple matter, compaction of arable soils is one of the most complex problems confronting agriculture. In spite of research advances during the past 20 years, no easy solution is evident. Our studies are continuing to define the problem more precisely and to assess the value of soil-amending materials such as shredded tree bark, which is a by-product of the pulp and paper industry. We hope to find ways of permitting farmers to practice monoculture without adverse effects. ■

On a augmenté de façon significative la production de foin de luzerne, grâce à un traitement au soufre, dans divers types de sols éloignés les uns des autres et situés dans le centre-sud de la Colombie-Britannique. La Station de recherches du ministère de l'Agriculture du Canada, à Summerland, a effectué un essai dans un terrain d'argile lourde à Lister, près de Creston. Les résultats ont accusé une réaction progressive dans la récolte, de la première à la cinquième année. L'accroissement annuel le plus marqué a été de 1,512 livres de matière sèche à l'acre.

SULFUR INCREASES ALFALFA GROWTH

F. M. CHAPMAN

British Columbia is called a pedologist's dream because many soil profiles and formations are located within a relatively small area. Variations in fertility are, however, a nightmare in terms of crop nutrition.

The Canada Department of Agriculture's Research Station at Summerland, B.C., is currently involved in field experiments to determine whether soils in alfalfa-growing areas of the province have adequate sulfur content to meet nutritional requirements of the legume crop.

Few soil-testing service laboratories analyze for sulfur. It is considered a minor element in growing alfalfa although the level required is 0.20 percent—only slightly less than that of phosphorus at 0.25 percent.

At present, sulfur deficiency in alfalfa is detected visually: young leaves, including the veins, turn from pale green to yellow. As the plant grows older and the deficiency more acute, yellowing becomes more

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pronounced. Unfortunately, nitrogen deficiency symptoms are similar, and the two can easily be confused. But our research shows a definite link between sulfur and nitrogen deficiencies. Low sulfur content in alfalfa tissue is often accompanied by low nitrogen content. A combined deficiency represents considerable loss in value for alfalfa as feed for livestock.

Soils differ widely in sulfur content and the yellow leaves symptomatic of sulfur deficiency in alfalfa occur at widely separated locations throughout British Columbia's south central interior.

SURVEY TECHNIQUE

A survey technique is useful in determining the relative fertility of soils and their suitability for alfalfa growing. By the survey method, samples of alfalfa tissue of similar maturity, are collected from areas where sulfur deficiency is suspected or visually detected.

Analysis after drying, determines whether the content is above or below the established critical level for normal plant growth. The sampling method defines the seriousness of a sulfur deficiency and the size of the area affected. In addition, sampling reduces the number of field experiments required to measure yield response when selected sulfur carriers are applied to the soil.

Sampling was used on an area of heavy clay soils near Creston, where sulfur deficiency symptoms in alfalfa had been observed for several years. Analyzed for total sulfur content, more than 75 percent of the collected alfalfa specimens had less than the established level of need. Low nitrogen content was also noted.

An alfalfa plot at Creston Substation, B.C.

SIGNIFICANT INCREASE

We conducted a five-year (1964-68) field experiment on Lister heavy clay, with a sulfur content of four parts per million. We found that yields of alfalfa hay increased significantly and progressively from the first to the fifth and final crop year.

A small, insignificant increase in yield over the check treatment was evident in the first crop year, as a result of gypsum applied at 200 pounds an acre in the previous fall. Subsequent annual fall applications of gypsum at a similar rate brought yield responses ranging from 10 percent in the second year to 64 percent in the fifth. Third and fourth year increases were 21 and 27 percent respectively.

Creston receives 19.25 inches of rainfall a year, insufficient to create water percolation through the heavy clay soil. The first crop-year's insignificant increase in yield may have resulted from lack of movement of applied sulfur into the root zone of alfalfa. The first delayed response made it obvious that premature decisions can be made about the benefit of applied sulfur in alfalfa growth. Had the experiment terminated before five years, we would have missed the major period of yield increase.

Because of low precipitation during the growing season, each alfalfa crop was subjected to considerable moisture stress. This was most pronounced during July when there was only approximately one inch of rainfall. As this period was between the first and second cutting, yields of the latter cut were seriously reduced each year.

Sulfur deficiency and lack of moisture reduced vigor in the alfalfa plant to a much greater extent than moisture stress alone. This was most pronounced in the fifth crop year, when a 64 percent increase in yield, amounting to 1,512 pounds per acre of dry matter was obtained from sulfur-treated alfalfa.

As crop yield continues to be pushed upwards, plant nutrition deficiencies will no doubt be given more attention.

Diagnosis of nutrition deficiencies in plants, on the basis of visual symptoms alone, is uncertain and expensive. Laboratory analyses should be used to determine the sulfur content of soils. Our experiment has shown that maximum yields of high quality alfalfa depend on an adequate supply of sulfur. ■

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